HEALTH IN TRANSITION

Translating developmental origins
of health and disease science to
improve future health in Africa

ANDREW J MACNAB,
ABDALLAH DAAR & CHRISTOFF PAUW
EDITORS

INTRODUCTION: NOTES ON 'THE FETUS IN THE WOMB' BY LEONARDO DA VINCI

Andrew J Macnab¹

This work must begin with the conception of man, and describe the nature of the womb and how the foetus lives in it, up to what stage it resides there, and in what way it quickens into life and feeds. Also, its growth and what interval there is between one stage of growth and another. What it is that forces it out from the body of the mother, and for what reasons it sometimes comes out of the mother's womb before the due time. – Leonardo da Vinci.²

1 Stellenbosch Institute for Advanced Study, Wallenberg Research Centre at Stellenbosch University, Stellenbosch, South Africa; Faculty of Medicine, Department of Paediatrics, University of British Columbia, Vancouver Canada.

2 Dunn, P.M. 1997. Leonardo Da Vinci (1452–1519) and reproductive anatomy. *Archives of Disease in Childhood - Fetal and Neonatal Edition*, 77(3):F249. [<https://doi.org/10.1136/fn.77.3.f249>].

The Fetus – pen and ink drawing – Leonardo da Vinci, 1611. Cover illustration reproduced by gracious permission of Her Majesty Queen Elizabeth II, Royal Collection Trust (inventory number 919102) / © Her Majesty Queen Elizabeth II 2019.

Leonardo da Vinci wrote these words when planning the book, *Of the Human Figure*, with anatomist Marc Antonio Della Torre.³ Far in advance of any concepts on the developmental origins of health and disease (DOHaD), Da Vinci, it can be argued, established informed inquiry into life during the first 1 000 days, by studying male and female reproductive anatomy, performing 30 dissections and drawing meticulous detail from the dissection of the cadaver of a pregnant woman, and a child of two years.⁴ He also wrote about the impact on health of diet, medicine and alcohol, and the importance of exercise and mental health.⁵ His pursuit of knowledge and seminal contributions to the understanding of human anatomy and physiology were indeed precursors to current inquiry into the importance of life during the first 1 000 days, making his illustration appropriate as the cover for this book.

The premature death of his collaborator was likely the reason that their book, *Of the Human Figure*, was never published. As we know Leonardo, however, left a unique and visionary series of anatomical drawings completed between 1510-1512, with perhaps the most famous being, *The Fetus in the Womb*, c.1511; housed in the Royal Collection at Windsor Castle and reproduced as the cover of this book by gracious permission of Her Majesty The Queen.⁶

In this small drawing (30.4 x 22 cm), made with red and black chalk and pen and ink, the fetus is shown in the now-familiar ‘fetal’ position with legs crossed at the ankles and the umbilical cord wrapped around the crossed legs. The uterus appears cut-through and opened-out, with an ovary in the left margin and the membranes in cross-section. Small ancillary sketches show the uterine membranes unfurling like the petals of a flower, details of the cord vessels, umbilical vein and the fetal liver and stomach.⁷

Leonardo’s drawings are considered to be the first to correctly depict the human fetus within the uterus, and illustrate cord vessels connecting to the liver. Leonardo is also credited with showing the uterus with only one chamber; thus contradicting theories of multiple uterine chambers which in the case of twins were believed

3 Ibid.

4 Gilson, H. 2020. Leonardo da Vinci's Embryological Drawings of the Fetus. *The Embryo Project Encyclopedia*. [<http://www.leonardo-da-vinci.net/embryo-in-the-womb/>] (Accessed 10 September 2019).

5 Dunn, 1997.

6 Royal Collection Trust. 2020. *Leonardo da Vinci (Vinci 1452-Ambiose 1519): Recto: The fetus in the womb. Verso: Notes on reproduction, with sketches of a fetus in utero, etc. c.1511*. [<https://bit.ly/31mOO7p>].

7 Ibid.

to hold each fetus in a separate compartment. Furthermore, these drawings and his accompanying notes illustrate his understanding of the umbilical cord blood vessels "not taking origin in any vein of the pregnant woman."⁸ Arguably, Leonardo thus pre-empted the discovery of the two independent, non-mixing fetal and maternal circulations made subsequently by Harvey and Hunter. And, while the quote below indicates that he did not identify the role of the heart or lungs in utero from his dissection of the dead fetus, he did write that the fetus was nourished by the mother.

In the case of this child the heart does not beat and it does not breathe because it lies continually in water. And if it were to breathe it would be drowned, and breathing is not necessary to it because it receives life and is nourished from the life and food of the mother.⁹

While accounts of this drawing often describe the fetus as being in the breech position, this arguably cannot be stated with certainty, as obviously we do not know the gestation of the pregnancy depicted. The gestation of the fetus at the time of Leonardo's dissection is relevant, as a fetus does not adopt the final position from which she/he will be delivered (either cephalic or breech) until between the 32nd and 36th week of pregnancy,¹⁰ hence there is a question as to whether this fetus had adopted the presentation from which delivery would have occurred. Physical criteria are used to reliably determine the maturity (gestational age) of a newly born infant from examination of various anatomical structures, but these markers do not appear to have been applied to estimate the gestational age of Leonardo's fetus previously. Two of the most reliable relate to the appearance of the ears and the soles of the feet, and as these parts of the fetus are clearly illustrated, their appearance can be used to estimate the maturity of Leonardo's fetus. From these, the gestation is probably close to term (40 weeks), as Leonardo draws ears with cartilage that appears well developed, and includes skin creases over the entire surface of the foot.¹¹ Hence, it is likely the fetus was a breech presentation.

As remarkable as Leonardo work is it proves not to be perfect; interestingly, the placenta as depicted is probably that of a cow from a previous animal dissection,

8 Ibid.

9 Dunn, 1997.

10 Cleveland Clinic. 2020. Fetal positions for birth. *Cleveland Clinic, Health Library: Articles*. [<https://my.clevelandclinic.org/health/articles/9677-fetal-positions-for-birth>].

11 Parkin, J.M., Hey, E.N. & Clowes, J.S. 1976. Rapid assessment of gestational age at birth. *Archives of Disease in Childhood - Fetal and Neonatal Edition*, 51(4):259-263. [<https://doi.org/10.1136%2Fadc.51.4.259>].

and Da Vinci also misbelieved that the umbilical cord was responsible for taking the fetus' urine outside of the uterus.¹²

Da Vinci never published his anatomical sketches; 'the fetus in the womb' and related work and observations were included in the third volume of his private notebooks which he left to his friend and pupil, Francesco Melzi. These notebooks, bought from his heirs, have since 1690 been part of the Royal Collection of Her Majesty The Queen.¹³ Leonardo's anatomical drawings demonstrate the rigour and inquisitiveness of a scientist as well as the skill of an artist and are rightly seen as the foundation of modern anatomical illustration.¹⁴ It is argued in parallel that his writing contains wisdom far ahead of its time when written 500 years ago, and I suggest that together, his words and images are relevant again today as unique ways to convey the message of DOHaD. Who can argue with his health advice?

If you would keep healthy, follow this regimen:

do not eat unless you feel inclined, and sup lightly; chew well, and let what you take be well cooked and simple. He who takes medicine does himself harm; do not give way to anger and avoid close air; hold yourself upright when you rise from table and do not let yourself sleep at midday. Be temperate with wine, take a little frequently, but not at other than the proper mealtimes, not on an empty stomach; neither protract nor delay the (visit to the) privy. When you take exercise, let it be moderate. Do not remain with the belly recumbent and the head lowered, and see that you are well covered at night. Rest your head and keep your mind cheerful; shun wantonness, and pay attention to diet.¹⁵

12 Cataldi, L. & Fanos, V. 2000. Leonardo da Vinci and his studies on the human fetus and the placenta. *Acta Biomed Ateneo Parmense*, 71(Supplement 1):405-406.

13 Royal Collection Trust, 2020.

14 Gilson, 2020.

15 Dunn, 1997.